



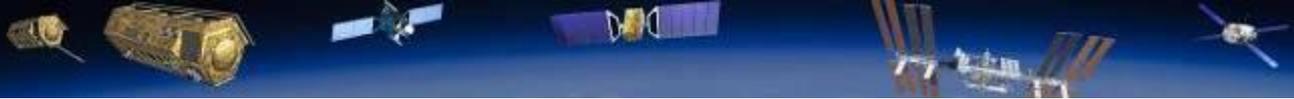
Real-time Stream Conversion to RTCM-3 MSM and RINEX-3 in IGS/MGEX Context

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Contents

- Which agencies and reference stations participate in M-GEX with real-time GNSS streams?
- Which manufacturers and receiver types could be involved?
- Which proprietary stream formats are in use?
- Is getting proprietary stream format documentation a problem?
- Are there problems with the proprietary stream contents?
- What is the status of MSM developments in RTCM?
- What is the status of phase alignments in that?
- Besides Galileo, are observations from COMPASS and QZSS accessible?
- Which tools are involved in stream conversion?
- Which tools can be used to access M-GEX streams and where can they be picked up?



Real-time M-GEX Overview

13 Agencies/Institutes	AGG_DITS, ASI, BKG, CNES, CUT, DLR, IGN, JAXA, KEG, KZU, NRCAN, TUD, SWEPOS
4 Manufacturers / 6 Receiver Types	Javad (Triumph Delta-G3TH) Leica (GRX1200+GNSS, GR10, GR25) Septentrio (PolaRx4) Trimble (NetR9)
4 Proprietary Formats	Public: JPS, SBF Non-public: LB2, RT27
6 Constellations	GPS, GLO, SBAS, GAL QZS, COM

Septentrio PolaRx4: Only SBF stream, no RTCM-3 MSM



Real-time M-GEX Streams, <http://mgex.igs-ip.net/home>

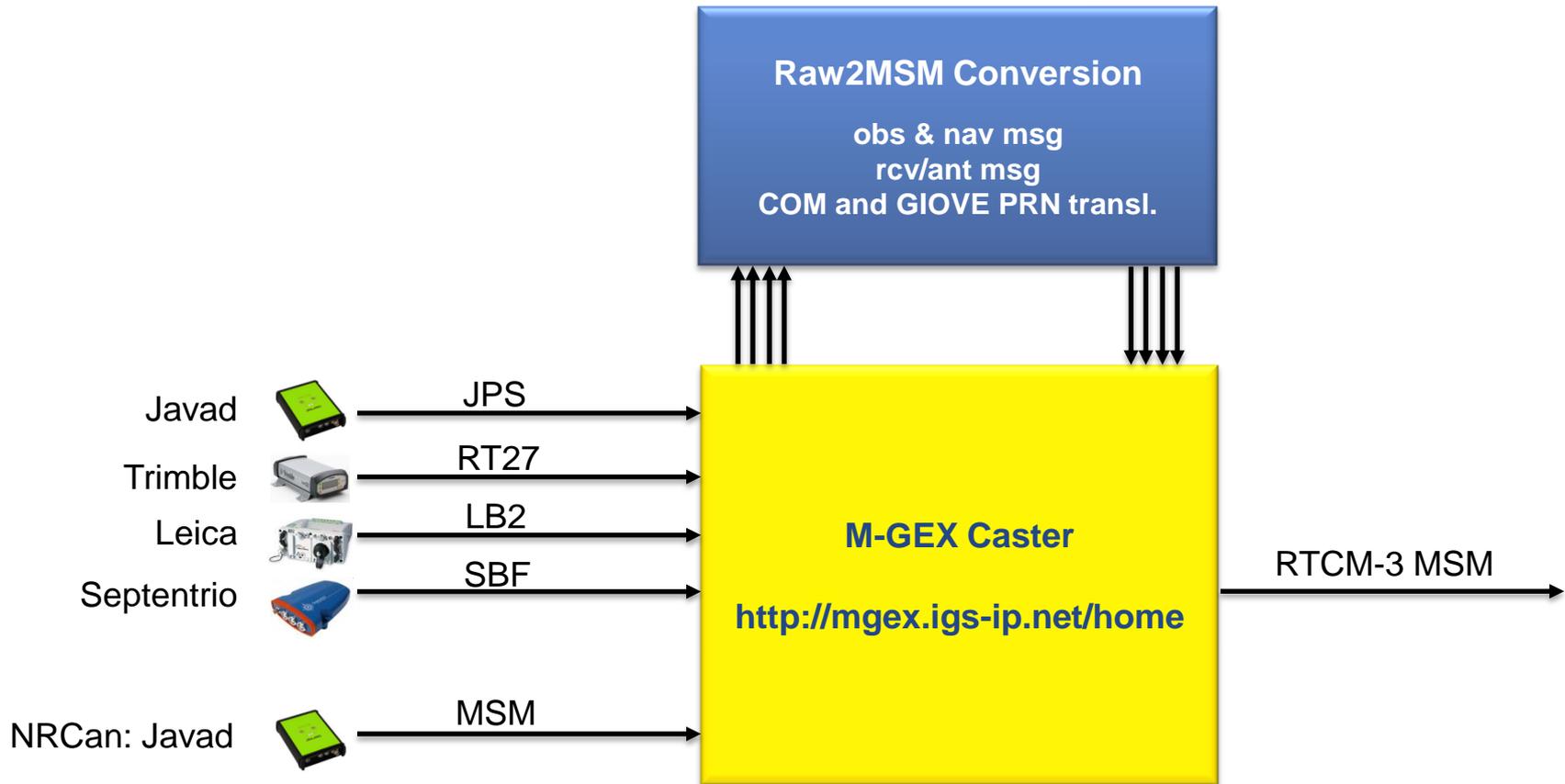
Agency	Station(s)	Receiver(s)	Raw	MSM	Constellations
AGG_DITS	M0SE	Leica GR25	LB2	☑	GRS(E?)
ASI	MATG	Leica GRX1200+GNSS	LB2	☑	GRS(E?)
BKG	CONX OHIX	Javad Delta-G3TH	JPS	☑	GRSE
		Leica GRX1200+GNSS	LB2	☑	GR(S?)E
CNES	DYNG, NKLG, TLSE	Trimble NetR9	RT27	☑	GRSE
CUT, TUD	CUT0, DLF1	Trimble NetR9	RT27	☑	GRSEJC
DLR	WTZX, UNSX	Javad Delta-G3TH	JPS	☑	GRSEJ
IGN	ABMF, BRST, GRAC, HARB, LMMF, REUN	Trimble NetR9	RT27	☑	GRSE
JAXA	GMSD	Trimble NetR9	RT27	☑	GREJC
KEG	MYVA	Leica GR10	LB2	☑	GRSE
KZU	KZN2	Trimble NetR9	RT27	☑	GRSEJC
NRCAN	RA3M	Javad Delta-G3TH	n/a	☑	GR
SWEPOS	KIR8, MAR7, ONS1	Trimble NetR9	RT27	☑	GRSE(J?)C
ROB	BRUX	Septentrio PolaRx4	SBF	☒	

CONX, OHIX = Currently unavailable

? = System likely supported, however, so far no proof for that



Real-time M-GEX RTCM-3 MSM Stream Generation





RTCM-3 MSM Application S/W

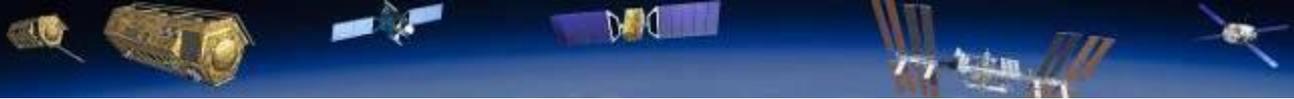
Software	Agency	Availability	Details
BNC, rtc3torinex	BKG	Open Source	RINEX generation from RTCM-3 Ntrip streams, supports legacy messages and MSM incl. extensions, all tracking modes/channels fully supported
clocks_and_orbits	BKG	Open Source	Supports SSR messages
RTCM3.cpp	DLR	Proprietary	Library for RTCM-3 message parsing, supports legacy messages, MSM and SSR messages
NtripRTCM3toRnx	DLR	Proprietary	RINEX generation from RTCM-3 Ntrip streams, legacy messages and MSM incl. extensions
NRCan	NRCan	Proprietary	Only GPS and GLONASS
MADOCA	JAXA	Under development	Converts BINEX, RTCM-3 legacy, and JPS streams to RTCM-3 MSM and RINEX, supports GPS, GLONASS, Galileo, QZSS
RTKLIB	Tomoji Takasu	Open Source	Accepts RTCM-3 legacy and MSM for RTK and RT-PPP, converts RTCM-3 to RINEX, library to handle RTCM-3 messages



Multi-GNSS: Available Systems

System	Identifier	SVs	Comment
GPS	G	31	–
GLONASS	R	24	Plus 7 spare/maintenance
GIOVE	E	2 (-1)	GIOVE-A decommissioned 30 June 2012
Galileo-IOV	E	2	Launch IOV 3 and 4: Oct 2012
QZSS	J	1	Incl. QZSS-SAIF, LEX
Compass	C	13	Planned launches: M2/M5 in Aug 2012, G6 in Oct 2012
SBAS	S	11	3 WAAS, 3 EGNOS, 1 GAGAN, 2 MSAS, 1 QZSS, 1 SDCM

SAIF - Submeter-class augmentation with integrity function



Status of Message Types in MGEX Streams

Message type	Contents
1004, 1011	GPS/GLONASS observations
1019, 1020	GPS/GLONASS ephemeris
1006, 1008	Station and antenna data
1033	Antenna and receiver description
1045	GALILEO ephemeris
1077	GPS HP MSM observations
1087	GLONASS HP MSM observations
1097	GALILEO HP MSM observations
1107, 1117, 1127	SBAS, QZSS, Compass HP MSM observations, no RTCM HP MSM draft existing



RINEX-3 Files from RTCM-3 Streams, Quarter Cycle Problem

Conversion Tool	Quarter Cycle
BNC, rtm3torinex	No change, no RINEX header comments
Others	???

No change of information from RTCM-3 MSM stream to RINEX-3 files.

However:

- Phases must be aligned and shifts reported in RINEX-3 header.
- But, no phase alignment in RTCM-3 MSM.
- Possible mismatch of “flex power” phase shifts in RTCM-3 MSM and RINEX-3
- Some uncertainties remain with regards to manufacturer phase shifts itself.



Known RTCM-3 MSM Issues

- Most NetR9 stations transmit Doppler only for one signal, some don't transmit Doppler at all
- Low sampling rate of GMSD station, firmware setup to 10 sec)
- Incomplete information in station/antenna msgs (1033) generated from raw data, additional options required in the software to cope with the situation
- Non-conformances
 - MSM with X tracing mode e.g. in BNC although not part of standard (except GPS L2X)
 - Use COMPASS, QZSS and SBAS msgs although not part of standard
- RTCM-3 MSM from NRCan limited to GPS and GLONASS



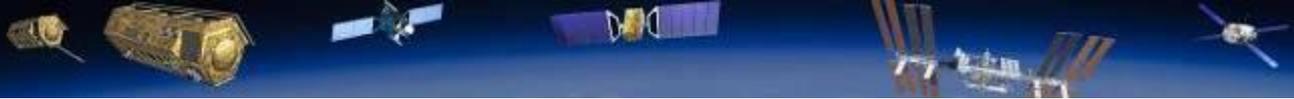
RTCM-3 MSM PROs and CONs

PROs

- Compact data format
- Industry standard
- Vendor- and receiver-independent
- Harmonized framework for observations messages, SSR messages, Network RTK messages
- IGS needs a lean, open, and flexible standard to quickly support multi-constellation GNSS real-time processing and data streaming
- RTCM-3 MSM not specifically focused on IGS needs
- Possible ways to go:
 - Tentative signal types in X tracking mode, or
 - Assigning proprietary message types for IGS.

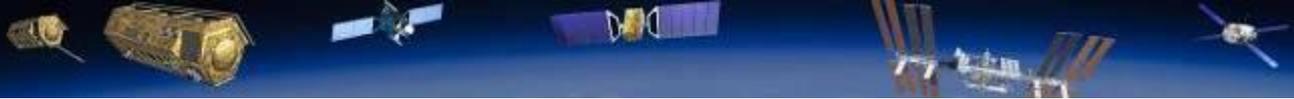
CONs

- Standardization process slow, can delay development of multi-GNSS processing
- Lack of flexibility
- Some overhead due to multiplicity of message flavors and constellation specific messages



RTCM-3 MSM for M-GEX, Status

- RTCM-MSM supports most RINEX 3.0x observation tracking signals.
- Current MSM messages defined to support GPS, GLONASS and Galileo.
- Draft QZSS support is planned for this fall, Compass later.
- RTCM-MSM documentation is under review and CDV in progress.
- Acceptance and interoperability testing completed in May 2012. Ashtech, BKG, and NRCan participated.
- Some Tracking modes (GPS L5X, Galileo L1X, L5X, L7X, L8X) not supported in current standard; will likely be added later.
- Removal of X tracking modes is a problem for IGS/MGEX since Javad receivers track these signals. Option: Get a proprietary message type assigned by RTCM for IGS.



RTCM-3 MSM for M-GEX, Status, cont'd

- Still some discussion and disagreement concerning signal phase alignment, final decision expected during September 2012 meeting.
- A GLONASS Code - Phase measurement bias was identified at the IGS Bias Workshop. RTCM-SC104 has amended a GLONASS Code – Phase message to the MSM CDV to support interoperability between all vendors of GLONASS streams and file.
Geo++ understanding:
 - There are no time biases. All receivers seem to have the same problem. Septentrio's latest firmware already removes them.
- Vote for acceptance as a RTCM-SC104 standard is expected to take place at the next RTCM-SC104 meeting in September, 2012.
- IGS has proposed additional messages that would allow the creation of a complete RINEX file from RTCM-MSM binary messages (no meta data stub file required).